sometimes, for gas and wood distillation retorts, etc., and similar places where quickness of setting is requisite. It is more often, however, used with some fibrous material to give it greater strength. Asbestos is the most commonly used material of these, as it will stand a high temperature. When that is not so important, straw, plush trimmings, hair, etc., are used as binders, while broken stone, glass, and various mineral substances are used as fillers, but they do not add anything to the strength. These lutes seem to be particularly suitable for oil vapors and hydrocarbon gases.

Formulas:

(1) Plaster and water.
(2) Plaster (wet) and asbestos.
(3) Plaster (wet) and straw.
(4) Plaster (wet) and plush trimmings.
(5) Plaster (wet) and hair.
(6) Plaster (wet) and broken stone, etc.

II. Hydraulic Cement. — Cement is used either alone or with sand, asbestos, etc. These lutes are suitable for nitric acid. When used with substances such as rosin or sulphur, cement is probably employed because it is in such a fine state of division and used as a filler and not because of any powers of setting by hydration.

Formulas:

(1) Cement—neat.
(2) Cement and asbestos.
(3) Cement and sand.

III. Clay.—This most frequently enters into the composition of lutes as a filler, but even then the very finely divided condition of certain grades renders it valuable, as it gives body to a liquid, such as linseed oil, which, unless stiffened, would be pervious to a gas, the clay in all cases being neutral. Thus, for luting pipes carrying chlorine, a stiff paste of clay and molasses has been suggested by Theo. Köller in *Die Surrogate*, but it soon gives way.

Formulas:

(1) Clay and linseed oil.
(2) Same, using fire clay.
(3) Clay and molasses.

(1) Is suitable for steam, etc.; (2) for chlorine, and (3) for oil vapors.

IV. Lime is used in the old lute known as putty, which consists of caustic lime and linseed oil. Frequently the lime is replaced by chalk and china clay, but the lime should be, in part at least, caustic, so as to form a certain amount of lime soap. Lime is also used in silicate and casein compositions, which are very strong and useful, but will be described elsewhere.

Formulas:

(1) Lime and boiled oil to stiff mass.
(2) Clay, etc., boiled oil to stiff mass.

V. Asphalt and Pitch. — These substances are used in lutes somewhat interchangeably. As a rule, pitch makes the stronger lutes. Tar is sometimes used, but, because of the light oils and, frequently, water contained, it is not so good as either of the others.

Asphalt dissolved in benzol is very useful for uniting glass for photographic, microscopical, and other uses. Also for coating wood, concrete, etc., where the melted asphalt would be too thick to cover well. Benzol is the cheapest solvent that is satisfactory for this purpose, as the only one that is cheaper would be a petroleum naphtha, which does not dissolve all the constituents of the asphalt. For waterproofing wood, brick, concrete, etc., melted asphalt alone is much used, but when a little paraffine is added, it improves its waterproofing qualities, and in particular cases boiled oil is also added to advantage.

Formulas:

1. Refined lake asphalt.

2.	Asphalt	4 parts
	Paraffine	1 part
3.	Asphalt	10 parts
	Paraffine	2 parts
	Boiled oil	1 part

Any of these may be thinned with hot benzol or toluol. Toluol is less volatile than benzol and about as cheap, if not cheaper, the straw-colored grades being about 24 cents per gallon.

Examples of so-called "stone cement" are:

4.	Pitch	8 parts
	Rosin	6 parts
	Wax	1 part
	Plaster	¼ to ½ part
5.	Pitch	8 parts
	Rosin	7 parts
	Sulphur	2 parts
	Stone powder	1 part

These compositions are used to unite slate slabs and stoneware for domestic, engineering, and chemical purposes. Various rosin and pitch mixtures are used for these purposes, and the proportions of these two ingredients are determined by the consistency desired. Sulphur and stone powder are added to prevent the formation of cracks, sulphur acting chemically and stone powder mechanically.

Where the lute would come in contact with acid or vapors of the same, limestone should not be the powder used, otherwise it is about the best. Wax is a useful ingredient to keep the composition from getting brittle with age.

A class of lutes under this general grouping that are much used are so-called "marine glues" (q. v.). They must be tough and elastic. When used for calking on a vessel they must expand and contract with the temperature and not crack or come loose.

Formulas:

6.	Pitch	3 parts
	Shellac	2 parts
	Pure crude rubber	1 part
7.	Pitch	1 part
	Shellac	1 part
	Rubber substitute	1 part

These are used by melting over a burner.

VI. Rosin, Shellac, and Wax. — A strong cement, used as a stone cement, is:

1.	Rosin	8 parts
	Wax	1 part
	Turpentine	1 part

It has little or no body, and is used in thin layers.

For nitric and hydrochloric acid vapors:

2.	Rosin	1 part
	Sulphur	1 part
	Fire clay	2 parts

Sulphur gives great hardness and permanency to rosin lutes, but this composition is somewhat brittle.

Good waterproof lutes of this class are:

3.	Rosin	1 part
	Wax	1 part
	Powdered stone	2 parts
4.	Shellac	5 parts
	Wax	1 part
	Turpentine	1 part
	Chalk, etc.	8 to 10 parts

For a soft air-tight paste for ground-glass surfaces:

5.	Wax	1 part
	Vaseline	1 part

6. A strong cement, without body, for metals (other than copper or alloys of same), porcelain, and glass is made by letting 1 part of finely powdered shellac stand with 10 parts of ammonia water until solution is effected.

VII. Rubber.—Because of its toughness, elasticity, and resistance to alterative influences, rubber is a very useful constituent in lutes, but its price makes its use very limited.

Leather Cement.

1.	Asphalt	1 part
	Rosin	1 part
	Gutta percha	4 parts
	Carbon disulphide	20 parts

To stand acid vapors:

2.	Rubber	1 part
	Linseed oil	3 parts
	Fire clay	3 parts

3. **Plain Rubber Cement.**—Cut the crude rubber in small pieces and then add the solvent. Carbon disulphide is the best, benzol good and much cheaper, but gasoline is probably most extensively used because of its cheapness.

4. To make corks and wood impervious to steam and water, soak them in a rubber solution as above; if it is desired to protect them from oil vapors, use glue composition. (See Section IX.)

VIII. Linseed Oil.—This is one of the most generally useful substances we have for luting purposes, if absorbed by a porous substance that is inert.

Formulas: 1. China clay of general utility for aqueous vapors.

Linseed oil of general utility for aqueous vapors.

2. Lime forming the well-known putty.

Linseed oil forming the well-known putty.

3. Red or white lead and linseed oil.

These mixtures become very strong when set and are best diluted with powdered glass, clay, or graphite. There are almost an endless number of lutes using metallic oxides and linseed oil. A very good one, not getting as hard as those containing lead, is:

4. Oxide of iron and linseed oil.

IX. Casein, Albumen, and Glue.—These, if properly made, become very tough and tenacious; they stand moderate heat and oil vapors, but not acid vapors.

1.	Finely powdered casein	12 parts
	Slaked lime (fresh)	50 parts
	Fine sand	50 parts
	Water to thick mush.	

A very strong cement which stands moderate heat is the following:

2.	Casein in very fine powder	1 part
	Rubbed up with silicate of soda	3 parts

A strong lute for general purposes,

which must be used promptly when made:

3. White of egg made into a paste with slaked lime.

A composition for soaking corks, wood, packing, etc., to render them impervious to oil vapors, is:

Gelatine or good glue	2 parts
Glycerine	½ to 1 part
Water	6 parts
Oil of wintergreen, etc., to keep from spoiling.	

X. Silicate of Oxychloride Cements.—For oil vapors, standing the highest heat:

1. A stiff paste of silicate of soda and asbestos.

Gaskets for superheated steam, retorts, furnaces, etc.:

2. Silicate of soda and powdered glass; dry the mixture and heat.

Not so strong, however, as the following:

3. Silicate of soda	50 parts
Asbestos	15 parts
Slaked lime	10 parts

Metal Cement:

4. Silicate of soda	1 part
Oxides of metal, such as zinc oxide; litharge, iron oxide, singly or mixed	1 part

Very hard and extra strong compositions:

5. Zinc oxide	2 parts
Zinc chloride	1 part
Water to make a paste.	
6. Magnesium oxide	2 parts
Magnesium chloride.	1 part
Water to make a paste.	

XI. Flour and Starch Compositions.—1. The well-known flaxseed poultice sets very tough, but does not stand water or condensed steam.

2. Flour and molasses, made by making a stiff composition of the two. This is an excellent lute to have at hand at all times for emergency use, etc.

3. Stiff paste of flour and strong zinc-chloride solution forms a more impervious lute, and is more permanent as a cement. This is good for most purposes, at ordinary temperature, where it would not be in contact with nitric-acid vapors or condensing steam.

4. A mixture of dextrine and fine sand makes a good composition, mainly used as core compound.

XII. Miscellaneous.—

1. Litharge.
Glycerine.

Mixed to form a stiff paste, sets and becomes very hard and strong, and is very useful for inserting glass tubes, etc., in iron or brass.

For a high heat:

2. Alumina	1 part
Sand	4 parts
Slaked lime	1 part
Borax	½ part
Water sufficient.	

A class of mixtures that can be classified only according to their intended use are core compounds.

I.—Dextrine, about	1 part
Sand, about	10 parts
With enough water to form a paste.	

II.—Powdered anthracite coal, with molasses to form a stiff paste.

III.—Rosin, partly saponified by soda lye	1 part
Flour	2 parts
Sand (with sufficient water)	4 parts

(These proportions are approximate and the amount of sand can be increased for some purposes.)

IV.—Glue, powdered	1 part
Flour	4 parts
Sand (with sufficient water)	6 parts

For some purposes the following mixture is used. It does not seem to be a gasket or a core compound:

V.—Oats (or wheat) ground	25 parts
Glue, powdered	6 parts
Sal ammoniac	1 part

Paper read by Samuel S. Sadtler before the Franklin Institute.

PASTES:

Dextrine Pastes.—

I.—Borax, powdered	60 parts
Dextrine, light yellow.	480 parts
Glucose	50 parts
Water	420 parts

By the aid of heat, dissolve the borax in the water and add the dextrine and glucose. Continue the heat, but do not let the mixture boil, and stir constantly until a homogeneous solution is obtained, from time to time renewing the water lost by evaporation with hot water. Finally, bring up to full weight (1,000 parts) by the addition of hot water, then strain through flannel. Prepared in this manner the paste remains bright and clear for a long time. It has extraordinary adhesive properties and dries very rapidly. If care is not taken to keep the cooking temperature below the boiling point of water, the paste is apt to become brown and to be very brittle on drying.

II.—Dissolve in hot water a sufficient quantity of dextrine to bring it to the consistency of honey. This forms a strong adhesive paste that will keep a long time unchanged, if the water is not allowed to evaporate. Sheets of paper may be prepared for extempore labels by coating one side with the paste and allowing it to dry; by slightly wetting the gummed side, the label will adhere to glass. This paste is very useful in the office or laboratory.

III.—Pour over 1,000 parts of dextrine 450 parts of soft water and stir the mixture for 10 minutes. After the dextrine has absorbed the water, put the mixture over the fire, or, preferably, on a water bath, and heat, with lively stirring for 5 minutes, or until it forms a light milk-like liquid, on the surface of which little bubbles begin to form and the liquid is apparently beginning to boil. Do not allow it to come to a boil. Remove from the fire and set in a bucket of cold water to cool off. When cold add to every 1,000 parts of the solution 51 parts glycerine and as much salicylic acid as will stand on the tip of a knife blade. If the solution is too thick, thin it with water that has been boiled and cooled off again. Do not add any more glycerine or the solution will never set.

IV.—Soften 175 parts of thick dextrine with cold water and 250 parts of boiling water added. Boil for 5 minutes and then add 30 parts of dilute acetic acid, 30 parts glycerine, and a drop or two of clove oil.

V.—Powder coarsely 400 parts dextrine and dissolve in 600 parts of water. Add 20 parts glycerine and 10 parts glucose and heat to 90° C. (195° F.).

VI.—Stir 400 parts of dextrine with water and thin the mass with 200 parts more water, 20 parts glucose, and 10 parts aluminum sulphate. Heat the whole to 90° C. (195° F.) in the water bath until the whole mass becomes clear and liquid.

VII.—Warm 2 parts of dextrine, 5 parts of water, 1 part of acetic acid, 1 part of alcohol together, with occasional stirring until a complete solution is attained.

VIII.—Dissolve by the aid of heat 100 parts of builders' glue in 200 parts of water add 2 parts of bleached shellac dissolved previously in 50 parts of alcohol. Dissolve by the aid of heat 50 parts of dextrine in 50 parts of water, and mix the two solutions by stirring the second slowly into the first. Strain the mixture through a cloth into a shallow dish and let it harden. When needed cut off a piece of sufficient size and warm until it becomes liquid and if necessary or advisable thin with water.

IX.—Stir up 10 parts of dextrine with sufficient water to make a thick broth. Then, over a light fire, heat and add 25 parts of sodium water glass.

X.—Dissolve 5 parts of dextrine in water and add 1 part of alum.

Fastening Cork to Metal.—In fastening cork to iron and brass, even when these are lacquered, a good sealing wax containing shellac will be found to serve the purpose nicely. Wax prepared with rosin is not suitable. The cork surface is painted with the melted sealing wax. The surface of the metal is heated with a spirit flame entirely free from soot, until the sealing wax melts when pressed upon the metallic surface. The wax is held in the flame until it burns, and it is then applied to the hot surface of the metal. The cork surface painted with sealing wax is now held in the flame, and as soon as the wax begins to melt the cork is pressed firmly on the metallic surface bearing the wax.

To Paste Celluloid on Wood, Tin, or Leather.—To attach celluloid to wood, tin, or leather, a mixture of 1 part of shellac, 1 part of spirit of camphor, 3 to 4 parts of alcohol and spirit of camphor (90°) is well adapted, in which 1 part of camphor is dissolved without heating in 7 parts of spirit of wine of 0.832 specific gravity, adding 2 parts of water.

To Paste Paper Signs on Metal or Cloth.—A piece of gutta percha of the same size as the label is laid under the latter and the whole is heated. If the heating cannot be accomplished by means of a spirit lamp the label should be ironed down under a protective cloth or paper in the same manner as woolen goods are pressed. This method is also very useful for attaching paper labels to minerals.

Paste for Fastening Leather, Oilcloth, or Similar Stuff to Table or Desk Tops, etc.—Use the same paste for leather as for oilcloth or other goods, but moisten the leather before applying the paste. Prepare the paste as follows: Mix 2¼ pounds of good wheat flour with 2 tablespoonfuls of pulverized gum arabic or powdered rosin and 2 tablespoonfuls of pulverized alum in a clean dish with water enough to make a uniformly thick batter; set it over a slow fire and stir continuously until the paste is uniform and free from lumps. When the mass has become so stout that the wooden spoon or stick will stand in it

upright, it is taken from the fire and placed in another dish and covered so that no skin will form on top. When cold, the table or desk top, etc., is covered with a thin coat of the paste, the cloth, etc., carefully laid on and smoothed from the center toward the edges with a rolling pin. The trimming of edges is accomplished when the paste has dried. To smooth out the leather after pasting, a woolen cloth is of the best service.

To Paste Paper on Smooth Iron.—Over a water bath dissolve 200 parts, by weight, of gelatine in 150 parts, by weight, of water; while stirring add 50 parts, by weight, of acetic acid, 50 parts alcohol, and 50 parts, by weight, of pulverized alum. The spot upon which it is desired to attach the paper must first be rubbed with a bit of fine emery paper.

Paste for Affixing Cloth to Metal.—

Starch.............	20 parts
Sugar.............	10 parts
Zinc chloride.......	1 part
Water.............	100 parts

Mix the ingredients and stir until a perfectly smooth liquid results entirely free from lumps, then warm gradually until the liquid thickens.

To Fix Paper upon Polished Metal.—Dissolve 400 parts, by weight, of dextrine in 600 parts, by weight, of water; add to this 10 parts, by weight, of glucose, and heat almost to boiling.

Albumen Paste.—Fresh egg albumen is recommended as a paste for affixing labels on bottles. It is said that labels put on with this substance, and well dried at the time, will not loosen even when bottles are put into water and left there for some time. Albumen, dry, is almost proof against mold or ferments. As to cost, it is but little if any higher than gum arabic, the white of one egg being sufficient to attach at least 100 medium-sized labels.

Paste for Parchment Paper.—The best agent is made by dissolving casein in a saturated aqueous solution of borax.

Medical Paste.—As an adhesive agent for medicinal purposes Professor Reihl, of Leipsic, recommends the viscous substance contained in the white mistletoe. It is largely present in the berries and the bark of the plant; it is called viscin, and can be produced at one-tenth the price of caoutchouc. Solutions in benzine may be used like those of caoutchouc without causing any irritation if applied mixed with medicinal remedies to the skin.

Paste That Will Not Mold.—Mix good white flour with cold water into a thick paste. Be sure to stir out all the lumps; then add boiling water, stirring all the time until thoroughly cooked. To 6 quarts of this add ½ pound light brown sugar and ¼ ounce corrosive sublimate, dissolved in a little hot water. When the paste is cool add 1 drachm oil of lavender. This paste will keep for a long time.

Pasting Wood and Cardboard on Metal.—In a little water dissolve 50 parts of lead acetate and 5 parts of alum. In another receptacle dissolve 75 parts of gum arabic in 2,000 parts of water. Into this gum-arabic solution pour 500 parts of flour, stirring constantly, and heat gradually to the boiling point. Mingle the solution first prepared with the second solution. It should be kept in mind that, owing to the lead acetate, this preparation is poisonous.

Agar Agar Paste.—The agar agar is broken up small, wetted with water, and exposed in an earthenware vessel to the action of ozone pumped under pressure into the vessel from the ozonizing apparatus. About an hour of this bleaches the agar agar and makes it freely soluble in boiling water, when solutions far more concentrated than has hitherto been possible can be prepared. On cooling, the solutions assume a milky appearance, but form no lumps and are readily reliquefied by heating. If the solution is completely evaporated, as of course happens when the adhesive is allowed to dry after use, it leaves a firmly holding mass which is insoluble in cold water. Among the uses to which the preparation can be applied are the dressing of textile fabrics and paper sizing, and the production of photographic papers, as well as the ordinary uses of an adhesive.

Strongly Adhesive Paste.—Four parts glue are soaked a few hours in 15 parts cold water, and moderately heated till the solution becomes perfectly clear, when 65 parts boiling water are added, while stirring. In another vessel 30 parts boiled starch are previously stirred together with 20 parts cold water, so that a thin, milky liquid without lumps results. The boiling glue solution is poured into this while stirring constantly, and the whole is kept boiling another 10 minutes.

Paste for Tissue Paper.—

(a) Pulverized gum arabic..............	2 ounces
White sugar........	4 drachms
Boiling water.......	3 fluidounces

(b) Common laundry starch.......... $1\frac{1}{2}$ ounces
Cold water......... 3 fluidounces
Make into a batter and pour into
Boiling water.......32 fluidounces

Mix (a) with (b), and keep in a wide-mouthed bottle.

Waterproof and Acidproof Pastes.—

I.—Chromic acid....... $2\frac{1}{2}$ parts
Stronger ammonia... 15 parts
Sulphuric acid...... $\frac{1}{2}$ part
Cuprammonium solution.......... 30 parts
Fine white paper.... 4 parts

II.—Isinglass, a sufficient quantity
Acetic acid........ 1 part
Water............ 7 parts

Dissolve sufficient isinglass in the mixture of acetic acid and water to make a thin mucilage.

One of the solutions is applied to the surface of one sheet of paper and the other to the other sheet, and they are then pressed together.

III.—A fair knotting varnish free from surplus oil is by far the best adhesive for fixing labels, especially on metal surfaces. It dries instantly, insuring a speedy job and immediate packing, if needful, without fear of derangement. It has great tenacity, and is not only absolutely damp-proof itself, but is actually repellent of moisture, to which all water pastes are subject. It costs more, but the additional expense is often infinitesimal compared with the pleasure of a satisfactory result.

Balkan Paste.—

Pale glue..........	4 ounces
White loaf sugar....	2 ounces
Powdered starch....	1 ounce
White dextrine......	$\frac{1}{2}$ pound
Pure glycerine......	3 ounces
Carbolic acid.......	$\frac{1}{4}$ ounce
Boiling water.......	32 ounces

Cut up the glue and steep it in $\frac{1}{2}$ pint boiling water; when softened melt in a saucepan; add sugar, starch, and dextrine, and lastly the glycerine, in which carbolic acid has been mixed; add remainder of water, and boil until it thickens. Pour into jars or bottles.

Permanent Paste.—

I.—Wheat flour........	1 pound
Water, cold........	1 quart
Nitric acid........	4 fluidrachms
Boric acid..........	40 grains
Oil of cloves........	20 minims

Mix the flour, boric acid, and water, then strain the mixture; add the nitric acid, apply heat with constant stirring until the mixture thickens; when nearly cold add the oil of cloves. This paste will have a pleasant smell, will not attract flies, and can be thinned by the addition of cold water as needed.

II.—Dissolve 4 ounces alum in 4 quarts hot water. When cool add as much flour as will make it of the usual consistency; then stir into it $\frac{1}{2}$ ounce powdered rosin; next add a little water in which a dozen cloves have been steeped; then boil it until thick as mush, stirring from the bottom all the time. Thin with warm water for use.

Preservatives for Paste.—Various antiseptics are employed for the preservation of flour paste, mucilage, etc. Boric and salicylic acids, oil of cloves, oil of sassafras, and solution of formaldehyde are among those which have given best service. A durable starch paste is produced by adding some borax to the water used in making it. A paste from 10 parts (weight) starch to 100 parts (weight) water with 1 per cent borax added will keep many weeks, while without this addition it will sour after six days. In the case of a gluing material prepared from starch paste and joiners' glue, borax has also demonstrated its preserving qualities. The solution is made by mixing 10 parts (weight) starch into a paste with water and adding 10 parts (weight) glue soaked in water to the hot solution; the addition of $\frac{1}{10}$ part (weight) of borax to the solution will cause it to keep for weeks. It is equal to the best glue, but should be warmed and stirred before use.

Board-Sizing.—A cheap sizing for rough, weather-beaten boards may be made by dissolving shellac in sal soda and adding some heavy-bodied pigment. This size will stick to grease spots. Linseed oil may be added if desired. Lime-water and linseed oil make a good heavy sizing, but hard to spread. They are usually used half and half, though these proportions may be varied somewhat.

Rice Paste.—Mix the rice flour with cold water, and boil it over a gentle fire until it thickens. This paste is quite white and becomes transparent on drying. It is very adherent and of great use for many purposes.

Casein Paste.—A solution of tannin, prepared from a bark or from commercial tannin, is precipitated with lime-water, the lime being added until the solution just turns red litmus paper blue. The supernatant liquid is then decanted.

and the precipitate is dried without artificial heat. The resulting calcium tannate is then mixed, according to the purpose for which the adhesive is intended, with from 1 to 10 times its weight of dry casein by grinding in a mill. The adhesive compound is soluble in water, petroleum, oils, and carbon bisulphide. It is very strong, and is applied in the form of a paste with water.

PASTES FOR PAPERHANGERS.

I.—Use a cheap grade of rye or wheat flour, mix thoroughly with cold water to about the consistency of dough, or a little thinner, being careful to remove all lumps; stir in a tablespoonful of powdered alum to a quart of flour, then pour in boiling water, stirring rapidly until the flour is thoroughly cooked. Let this cool before using, and thin with cold water.

II.—Venetian Paste.—

(*a*) 4 ounces white or fish glue
8 fluidounces cold water
(*b*) 2 fluidounces Venice turpentine
(*c*) 1 pound rye flour
16 fluidounces (1 pint) cold water
(*d*) 64 fluidounces ($\frac{1}{2}$ gallon) boiling water

Soak the 4 ounces of glue in the cold water for 4 hours; dissolve on a water bath (glue pot), and while hot stir in the Venice turpentine. Make up (*c*) into a batter free from lumps and pour into (*d*). Stir briskly, and finally add the glue solution. This makes a very strong paste, and it will adhere to a painted surface, owing to the Venice turpentine in its composition.

III.—Strong Adhesive Paste.—

(*a*) 4 pounds rye flour
$\frac{1}{2}$ gallon cold water
(*b*) $1\frac{1}{2}$ gallons boiling water
(*c*) 2 ounces pulverized rosin

Make (*a*) into a batter free from lumps; then pour into (*b*). Boil if necessary, and while hot stir in the pulverized rosin a little at a time. This paste is exceedingly strong, and will stick heavy wall paper or thin leather. If the paste be too thick, thin with a little hot water; never thin paste with cold water.

IV.—Flour Paste.—

(*a*) 2 pounds wheat flour
32 fluidounces (1 quart) cold water
(*b*) 1 ounce alum
4 fluidounces hot water
(*c*) 96 fluidounces ($\frac{3}{4}$ gallon) boiling water

Work the wheat flour into a batter free from lumps with the cold water. Dissolve the alum as designated in (*b*). Now stir in (*a*) and (*c*) and, if necessary, continue boiling until the paste thickens into a semitransparent mucilage, after which stir in solution (*b*). The above makes a very fine paste for wall paper.

V.—Elastic or Pliable Paste.—

(*a*) 4 ounces common starch
2 ounces white dextrine
10 fluidounces cold water
(*b*) 1 ounce borax
3 fluidounces glycerine
64 fluidounces ($\frac{1}{2}$ gallon) boiling water

Beat to a batter the ingredients of (*a*). Dissolve the borax in the boiling water; then add the glycerine, after which pour (*a*) into solution (*b*). Stir until it becomes translucent. This paste will not crack, and, being very pliable, is used for paper, cloth, leather, and other material where flexibility is required.

VI.—A paste with which wall paper can be attached to wood or masonry, adhering to it firmly in spite of dampness, is prepared, as usual, of rye flour, to which, however, are added, after the boiling, $8\frac{1}{2}$ parts, by weight, of good linseed-oil varnish and $8\frac{1}{2}$ parts, by weight, of turpentine to every 500 parts, by weight.

VII.—Paste for Wall Paper.—Soak 18 pounds of bolus (bole) in water, after it has been beaten into small fragments, and pour off the supernatant water. Boil 10 ounces of glue into glue water, mix it well with the softened bolus and 2 pounds plaster of Paris and strain through a sieve by means of a brush. Thin the mass with water to the consistency of a thin paste. The paste is now ready for use. It is not only much cheaper than other varieties, but has the advantage over them of adhering better to whitewashed walls, and especially such as have been repeatedly coated over the old coatings which were not thoroughly removed. For hanging fine wall paper this paste is less commendable, as it forms a white color, with which the paper might easily become soiled if great care is not exercised in applying it. If the fine wall paper is mounted on ground paper, however, it can be recommended for pasting the ground paper on the wall.

LABEL PASTES:

Pastes to Affix Labels to Tin.—Labels separate from tin because the paste becomes too dry. Some moisture is presumably always present; but more is required to cause continued adhesion in the case of tin than where the container is of

glass. Paste may be kept moist by the addition of calcium chloride, which is strongly hygroscopic, or of glycerine.

The following formulas for pastes of the type indicated were proposed by Leo Eliel:

I.—Tragacanth	1 ounce
Acacia	4 ounces
Thymol	14 grains
Glycerine	4 ounces
Water, sufficient to make	2 pints

Dissolve the gums in 1 pint of water, strain, and add the glycerine, in which the thymol is suspended; shake well and add sufficient water to make 2 pints. This separates on standing, but a single shake mixes it sufficiently for use.

II.—Rye flour	8 ounces
Powdered acacia	1 ounce
Glycerine	2 ounces
Oil of cloves	40 drops

Rub the rye flour and acacia to a smooth paste with 8 ounces of cold water; strain through cheese cloth, and pour into 1 pint of boiling water, and continue the heat until as thick as desired. When nearly cold add the glycerine and oil of cloves.

III.—Rye flour	5 parts
Venice turpentine	1 part
Liquid glue, a sufficient quantity	

Rub up the flour with the turpentine and then add sufficient freshly prepared glue (glue or gelatine dissolved in water) to make a stiff paste. This paste dries slowly.

IV.—Dextrine	2 parts
Acetic acid	1 part
Water	5 parts
Alcohol, 95 per cent	1 part

Dissolve the dextrine and acetic acid in water by heating together in the water bath, and to the solution add the alcohol.

V.—Dextrine	3 pounds
Borax	2 ounces
Glucose	5 drachms
Water	3 pints 2 ounces

Dissolve the borax in the water by warming, then add the dextrine and glucose, and continue to heat gently until dissolved.

Another variety is made by dissolving a cheap Ghatti gum in limewater, but it keeps badly.

VI.—Add tartaric acid to thick flour paste. The paste is to be boiled until quite thick, and the acid, previously dissolved in a little water, is added, the proportion being about 2 ounces to the pint of paste.

VII.—Gum arabic, 50 parts; glycerine, 10 parts; water, 30 parts; liq. Stibii chlorat., 2 parts.

VIII.—Boil rye flour and strong glue water into a mass to which are added, for 1,000 parts, good linseed-oil varnish 30 parts and oil of turpentine 30 parts. This mixture furnishes a gluing agent which, it is claimed, even renders the labels proof against being loosened by moisture.

IX.—Pour 140 parts of distilled cold water over 100 parts of gum arabic in a wide-necked bottle and dissolve by frequent shaking. To the solution, which is ready after standing for about 3 days, add 10 parts of glycerine; later, 20 parts of diluted acetic acid, and finally 6 parts of aluminum sulphate, then straining it through a fine-hair sieve.

X.—Good glue is said to be obtained by dissolving 1 part of powdered sugar in 4 parts of soda water glass.

XI.—A glue for bottle labels is prepared by dissolving borax in water; soak glue in this solution and dissolve the glue by boiling. Carefully drop as much acetic acid into the solution as will allow it to remain thin on cooling. Labels affixed with this agent adhere firmly and do not become moldy in damp cellars.

XII.—Dissolve some isinglass in acetic acid and brush the labels over with it. There will be no cause to complain of their coming off, nor of striking through the paper. Take a wide-mouthed bottle, fill about two-thirds with commercial acetic acid, and put in as much isinglass as the liquid will hold, and set aside in a warm place until completely dissolved. When cold it should form a jelly. To use it place the bottle in hot water. The cork should be well-fitting and smeared with vaseline or melted paraffine.

How to Paste Labels on Tin.—Brush over the entire back of the label with a flour paste, fold the label loosely by sticking both ends together without creasing the center, and throw to one side until this process has been gone through with the whole lot. Then unfold each label and place it on the can in the regular manner. The paste ought not to be thicker than maple syrup. When of this consistency it soaks through the label and makes it pliable and in a condition to be easily rubbed into position. If the paste is too thick it dries quickly, and does not soak through the label sufficiently. After the labels have been placed upon the cans the latter must be

kept apart until dry. In putting the paste upon the labels in the first place, follow the method of placing the dry labels over one another, back sides up, with the edge of each just protruding over the edge of the one beneath it, so that the fingers may easily grasp the label after the pasting has been done.

Druggists' Label Paste.—This paste, when carefully made, is an admirable one for label use, and a very little will go a long way:

Wheat flour........	4	ounces
Nitric acid.........	1	drachm
Boric acid..........	10	grains
Oil of cloves	5	drops
Carbolic acid.......	½	drachm

Stir flour and water together, mixing thoroughly, and add the other ingredients. After the stuff is well mixed, beat it, watching very carefully and removing the instant it stiffens.

To Attach Glass Labels to Bottles.—Melt together 1 part of rosin and 2 parts of yellow wax, and use while warm.

Photographic Mountants (see also Photography).—Owing to the nature of the different papers used for printing photographs, it is a matter of extreme importance to use a mountant that shall not set up decomposition in the coating of the print. For example, a mountant that exhibits acidity or alkalinity is injurious with most varieties of paper; and in photography the following formulas for pastes, mucilages, etc., have therefore been selected with regard to their absolute immunity from setting up decomposition in the print or changing its tone in any way. One of the usual mountants is rice starch or else rice water. The latter is boiled to a thick jelly, strained, and the strained mass used as an agglutinant for attaching photographic prints to the mounts. There is nothing of an injurious nature whatever in this mountant, neither is there in a mucilage made with gum dragon.

This gum (also called gum tragacanth) is usually in the form of curls (i.e., leaf gum), which take a long time to properly dissolve in water—several weeks, in fact—but during the past few years there has been put on the market a powdered gum dragon which does not occupy so many days in dissolving. To make a mucilage rom gum dragon a very large volume of water is required. For example, 1 ounce of the gum, either leaf or powder, will swell up and convert 1 gallon of water into a thickish mucilage in the course of 2 or 3 weeks. Only cold water must be used, and before using the mucilage, all whitish lumps (which are particles of undissolved gum) should be picked out or else the mucilage strained. The time of solution can be considerably shortened (to a few hours) by acidifying the water in which the gum is placed with a little sulphuric or oxalic acid; but as the resultant mucilage would contain traces of their presence, such acids are not permissible when the gum-dragon mucilage is to be used for mounting photographs.

Glycerine and gum arabic make a very good adhesive of a fluid nature suited to mounting photographs; and although glycerine is hygroscopic by itself, such tendency to absorb moisture is checked by the reverse nature of the gum arabic; consequently an ideal fluid mucilage is produced. The proportions of the several ingredients are these:

Gum arabic, genuine (gum acacia, not Bassora gum).....	4 ounces
Boiling water.......	12 ounces
Glycerine, pure.....	1 ounce

First dissolve the gum in the water, and then stir in the glycerine, and allow all *débris* from the gum to deposit before using. The following adhesive compound is also one that is free from chemical reactions, and is suited for photographic purposes:

Water.............	2 pints
Gum dragon, powdered...........	1 ounce
Gum arabic, genuine	4 ounces
Glycerine..........	4 ounces

Mix the gum arabic with half the water, and in the remainder of the water dissolve the gum dragon. When both solids are dissolved, mix them together, and then stir in the glycerine.

The following paste will be found r useful mountant:

Gum arabic, genuine	1 ounce
Rice starch.........	1 ounce
White sugar........	4 ounces
Water, q. s.	

Dissolve the gum in just sufficient water to completely dissolve it, then add the sugar, and when that has completely dissolved stir in the starch paste, and then boil the mixture until the starch is properly cooked.

A very strong, stiff paste for fastening cardboard mounts to frames, wood, and other materials is prepared by making a bowl of starch paste in the usual way, and then adding 1 ounce of Venice turpentine per pound of paste, and boil-

ing and stirring the mixture until the thick turpentine has become well incorporated. Venice turpentine stirred into flour paste and boiled will also be found a very adhesive cement for fastening cardboard, strawboard, leatherette, and skiver leather to wood or metal; but owing to the resinous nature of the Venice turpentine, such pastes are not suitable for mounting photographic prints. The following half-dozen compounds are suitable mountants to use with silver prints:

Alcohol, absolute....	10 ounces
Gelatine, good......	1 ounce
Glycerine........	½ to 1 ounce

Soak the gelatine in water for an hour or two until it is completely softened; take the gelatine out of the water, and allow it to drain, and put it into a bottle and pour alcohol over it; add the glycerine (if the gelatine is soft, use only ½ ounce; if the gelatine is hard, use 1 ounce of the glycerine), then melt the gelatine by standing the bottle in a vessel of hot water, and shake up very well. For use, remelt by heat. The alcohol prevents the prints from stretching or cockling, as they are apt to, under the influence of the gelatine.

In the following compound, however, only sufficient alcohol is used to serve as an antiseptic, and prevent the agglutinant from decomposing: Dissolve 4 ounces of photographic gelatine in 16 ounces of water (first soaking the gelatine therein for an hour or two until it is completely softened), then remove the gelatine from the water, allow it to drain, and put it into the bottle, and pour the alcohol over it, and put in the glycerine (if the gelatine is soft, use only ½ ounce; if the gelatine is hard, use 1 ounce of the glycerine), then melt the gelatine by standing the bottle in a vessel of hot water, and shake up well and mix thoroughly. For use, remelt by heat. The alcohol prevents the print from stretching or cockling up under the influence of the gelatine.

The following paste agglutinant is one that is very permanent and useful for all purposes required in a photographic studio: Take 5 pints of water, 10 ounces of arrowroot, 1 ounce of gelatine, and a ½ pint (10 fluidounces) of alcohol, and proceed to combine them as follows: Make arrowroot into a thick cream with a little of the water, and in the remainder of the water soak the gelatine for a few hours, after which melt the gelatine in the water by heating it, add the arrowroot paste, and bring the mixture to the boil and allow to boil for 4 or 5 minutes, then allow to cool, and mix in the alcohol, adding a few drops of oil of cloves.

Perhaps one of the most useful compounds for photographic purposes is that prepared as follows: Soak 4 ounces of hard gelatine in 15 ounces of water for a few hours, then melt the gelatine by heating it in a glue pot until the solution is quite clear and free from lumps. Add 6 oz. of starch to 65 oz. of cold water, stir until free from lumps. Pour this into the boiling gelatine solution, and continue stirring, and if the starch is not completely cooked, boil up the mixture for a few minutes until it "blows," being careful to keep it well stirred so as not to burn; when cold add a few drops of carbolic acid or some essential oil as an antiseptic to prevent the compound from decomposing or becoming sour.

A useful photographic mucilage, which is very liquid, is obtained by mixing equal bulks of gum-arabic and gum-dragon mucilages of the same consistence. The mixture of these mucilages will be considerably thinner than either of them when alone.

As an agglutinant for general use in the studio, the following is recommended: Dissolve 2 ounces of gum arabic in 5 ounces of water, and for every 250 parts of the mucilage add 20 parts of a solution of sulphate of aluminum, prepared by dissolving 1 part of the sulphate in 20 parts of water (common alum should not be used, only the pure aluminum sulphate, because common alum is a mixture of sulphates, and usually contaminated with iron salts). The addition of the sulphate solution to the gum mucilage renders the latter less hygroscopic, and practically waterproof, besides being very adhesive to any materials, particularly those exhibiting a smooth surface.

MUCILAGES:

For Affixing Labels to Glass and Other Objects.—I.—The mucilage is made by simply pouring over the gum enough water to a little more than cover it, and then, as the gum swells, adding more water from time to time in small portions, until the mucilage is brought to such consistency that it may be easily spread with the brush. The mucilage keeps fairly well without the addition of any antiseptic.

II.—Tragacanth.......	1 ounce
Acacia...........	4 ounces
Thymol.........	14 grains
Glycerine........	4 ounces
Water, sufficient to make..........	2 pints

Dissolve the gums in 1 pint of water, strain and add the glycerine, in which the thymol is suspended; shake well and add sufficient water to make 2 pints. This separates on standing, but a single shake mixes it sufficiently for use.

III.—Rye flour.......	8 ounces
Powdered acacia.	1 ounce
Glycerine.......	2 ounces
Oil of cloves.....	40 drops
Water, a sufficient quantity.	

Rub the rye flour and the acacia to a smooth paste with 8 ounces of cold water; strain through cheese cloth, and pour into 1 pint of boiling water and continue the heat until as thick as desired. When nearly cold add the glycerine and oil of cloves.

IV.—One part, by weight, of tragacanth, when mixed with 95-per-cent alcohol to form 4 fluidounces, forms a liquid in which a portion of the tragacanth is dissolved and the remainder suspended; this remains permanently fluid, never deteriorates, and can be used in place of the present mucilage; 4 to 8 minims to each ounce of mixture is sufficient to suspend any of the insoluble substances usually given in mixtures.

V.—To 250 parts of gum-arabic mucilage add 20 parts of water and 2 parts of sulphate of alumina and heat until dissolved.

VI.—Dissolve ½ pound gum tragacanth, powdered, ¼ pound gum arabic, powdered, cold water to the desired consistency, and add 40 drops carbolic acid.

Mucilage of Acacia.—Put the gum, which should be of the best kind, in a flask the size of which should be large enough to contain the mucilage with about one-fifth of its space to spare (i. e., the product should fill it about four-fifths full). Now tare, and wash the gum with distilled water, letting the latter drain away as much as possible before proceeding further. Add the requisite quantity of distilled water slowly, which, however, should first have added to it about 10 per cent of limewater. Now cork the flask, and lay it, without shaking, horizontally in a cool place and let it remain quietly for about 3 hours, then give it a half turn to the right without disturbing its horizontal position. Repeat this operation three or four times during the day, and keep it up until the gum is completely dissolved (which will not be until the fourth day probably), then strain through a thin cloth previously wet with distilled water, avoiding, in so doing, the formation of foam or bubbles. This precaution should also be observed in decantation of the percolate into smaller bottles provided with paraffine corks. The small amount of limewater, as will be understood, is added to the solvent water in order to prevent the action of free acid.

Commercial Mucilage. — Dissolve ½ pound white glue in equal parts water and strong vinegar, and add ¼ as much alcohol and ½ ounce alum dissolved in a little water. To proceed, first get good glue and soak in cold water until it swells and softens. Use pale vinegar. Pour off the cold water, then melt the glue to a thick paste in hot water, and add the vinegar hot. When a little cool add the alcohol and alum water.

To Render Gum Arabic More Adhesive.—I.—Add crystallized aluminum sulphate in the proportion of 2 dissolved in 20 parts of water to 250 parts of concentrated gum solution (75 parts of gum in 175 parts of water).

II.—Add to 250 parts of concentrated gum solution (2 parts of gum in 5 parts of water) 2 parts of crystallized aluminum sulphate dissolved in 20 parts of water. This mixture glues even unsized paper, pasteboard on pasteboard, wood on wood, glass, porcelain, and other substances on which labels frequently do not adhere well.

Envelope Gum.—The gum used by the United States Government on postage stamps is probably one of the best that could be used not only for envelopes but for labels as well. It will stick to almost any surface. Its composition is said to be the following:

Gum arabic.........	1 part
Starch..............	1 part
Sugar...............	4 parts
Water, sufficient to give the desired consistency.	

The gum arabic is first dissolved in some water, the sugar added, then the starch, after which the mixture is boiled for a few minutes in order to dissolve the starch, after which it is thinned down to the desired consistency.

Cheaper envelope gums can be made by substituting dextrine for the gum arabic, glucose for the sugar, and adding boric acid to preserve and help stiffen it.

Mucilage to Make Wood and Pasteboard Adhere to Metals.—Dissolve 50 parts, by weight, of lead acetate together with 5 parts, by weight, of alum in a little water. Make a separate solution of 75 parts, by weight, of gum arabic in 2,000 parts, by weight, of water, stir in this 500

parts, by weight, of flour, and heat slowly to boiling, stirring the while. Let it cool somewhat, and mix with it the solution containing the lead acetate and alum, stirring them well together.

Preservation of Gum Solution.—Put a small piece of camphor in the mucilage bottle. Camphor vapors are generated which kill all the bacterial germs that have entered the bottle. The gum maintains its adhesiveness to the last drop.

Mucilage in Stick Form.—This is known as mouth or lip glue, for the reason that the stick is to be moistened with the lips and rubbed on the article to be gummed.

1 ounce isinglass
1 ounce white glue
¼ ounce sugar
1 ounce water

Boil together until the concentration is such that when cold the gum will be the required thickness. Mould into any desired shape.

AGATE, BUTTONS OF ARTIFICIAL.

Prepare a mixture or frit of 33 parts of quartz sand, 65 parts calcium phosphate, and 2 parts of potash. The frit, which has been reduced by heat to the fusing point, is finely ground, intimately mingled with a small quantity of kaolin and pressed in molds which yield button-shaped masses. These masses, after having been fired, are given a transparent glaze by any of the well-known processes.

AGING, SILVER AND GOLD:

See Plating.

AIR BATH.

Metal walls of air baths are attacked when heating or drying substances, which give off acid vapors. For such cases the following apparatus is suggested. For the production of the drying apparatus take a flask with the bottom burst off or a bell jar tubulated above. This is placed either upon a sand bath or upon asbestos paper, previously laid upon a piece of sheet iron. The sand bath or the sheet iron is put on a tripod, so that it can be heated by means of a burner placed underneath. The substance to be dried is placed in a glass or porcelain dish, which is put under the bell jar, and if desired the drying dish may be hung on the tripod. For regulating the temperature the tubulure of the jar is closed with a pierced cork, through whose aperture the thermometer is thrust. In order to permit the vapors to escape, the cork is grooved lengthwise along the periphery.

AIR BUBBLES IN GELATINE:

See Gelatine.

AIR, EXCLUSION OF, FROM SOLUTIONS:

See Photography.

AIR-PURIFYING.

Ozonatine is a fragrant air-purifying preparation consisting of dextrogyrate turpentine oil scented with slight quantities of fragrant oils.

ALABASTER CLEANING:

See Cleaning Preparations and Methods.

ALBATA METAL:

See Alloys.

ALBUMEN IN URINE, DETECTION OF.

The following is a simple and accurate method for the determination of albumen in urine:

In a test tube filter 5 cubic centimeters of urine which should be clear. If the urine is turbid, it indicates the presence of protein or phosphate. Heat till it boils gently at the surface and add gradually to it 3-5 drops of 10 per cent acetic acid. If the precipitate disappears phosphates are present whereas if the precipitate remains and becomes more flocculent albumen is present.

ALBUMEN PAPER:

See Photography.

Alcohol

TEST FOR PRESENCE OF WOOD ALCOHOL IN GRAIN ALCOHOL.

A simple method for detecting the presence of wood alcohol in grain alcohol is as follows: Heat to redness a small spiral wound from copper wire and immerse in the liquid contained in a test tube. Repeat several times so as to insure reduction of the wood alcohol if present. Add a few crystals of resorcinol to the liquid and when dissolved pour cautiously down the side of the tube concentrated sulphuric acid so as to form a bottom layer. If wood alcohol is present a characteristic violet ring will form at the zone of contact of the two liquids. Further matter is found under the heading

"Spirit"; likewise methods of denaturing and a list of denaturants.

ALCOHOL, DILUTION OF:
See Tables.

Alcohol, Tests for Absolute.—The committee for the compilation of the German Arzneibuch established the following tests for the determination of absolute alcohol:

Absolute alcohol is a clear, colorless, volatile, readily inflammable liquid which burns with a faintly luminous flame. Absolute alcohol has a peculiar odor, a burning taste, and does not affect litmus paper. Boiling point, 78.50. Specific gravity, 0.795 to 0.797. One hundred parts contain 99.7 to 99.4 parts, by volume, or 99.6 to 99.0 parts, by weight, of alcohol.

Absolute alcohol should have no foreign smell and should mix with water without cloudiness.

After the admixture of 5 drops of silver-nitrate solution, 10 cubic centimeters of absolute alcohol should not become turbid or colored even on heating.

A mixture of 10 cubic centimeters of absolute alcohol and 0.2 cubic centimeter of potash lye evaporated down to 1 cubic centimeter should not exhibit an odor of fusel oil after supersaturation with dilute sulphuric acid.

Five cubic centimeters of sulphuric acid, carefully covered, in a test tube, with a stratum of 5 cubic centimeters of absolute alcohol, should not form a rose-colored zone at the surface of contact, even on standing for some time.

The red color of a mixture of 10 cubic centimeters of absolute alcohol and 1 cubic centimeter of potassium-permanganate solution should not pass into yellow before 20 minutes.

Absolute alcohol should not be dyed by hydrogen sulphide water or by aqueous ammonia.

Five cubic centimeters of absolute alcohol should not leave behind a weighable residue after evaporation on water bath.

Absolute Alcohol.—If gelatine be suspended in ordinary alcohol it will absorb the water, but as it is insoluble in alcohol, that substance will remain behind, and thus nearly absolute alcohol will be obtained without distillation.

Perfumed Denaturized Alcohol.—

East India lemon oil	1,250 parts
Mirbane oil	1,000 parts
Cassia oil	50 parts
Clove oil	75 parts
Lemon oil	100 parts
Amyl acetate	500 parts
Spirit (95 per cent)	7,000 parts

Dissolve the oils in the spirit and add the amyl acetate. The mixture serves for destroying the bad odor of denaturized spirit in distilling. Use 50 parts of the perfume per 1,000 parts of spirit.

Solid Alcohol.—I.—Heat 1,000 parts of denaturized alcohol (90 per cent) in a flask of double the capacity on the water bath to about 140° F., and then mix with 28 to 30 parts of well-dried, rasped Venetian soap and 2 parts of gum lac. After repeated shaking, complete dissolution will take place. The solution is put, while still warm, into metallic vessels, closing them up at once and allowing the mixture to cool therein. The admixture of gum lac effects a better preservation and also prevents the evaporation of the alcohol. On lighting the solid spirit the soap remains behind.

II.—Smaragdine is a trade name for solidified alcohol. It consists of alcohol and gun cotton, colored with malachite green. It appears in the market in the form of small cubes.

Alcohol in Fermented Beers.—Experience has shown that ¼ pound of sugar to 1 gallon of water yields about 2 per cent of proof spirit, or about 1 per cent of absolute alcohol. Beyond this amount it is not safe to go, if the legal limit is to be observed, yet a ginger beer brewed with ¼ pound per gallon of sugar would be a very wishy-washy compound, and there is little doubt that a much larger quantity is generally used. The more sugar that is used—up to 1¼ or 1½ pounds per gallon—the better the drink will be and the more customers will relish it; but it will be as "strong" as lager and contain perhaps 5 per cent of alcohol, which will make it anything but a "temperance" drink. Any maker who is using as much as even ½ pound of sugar per gallon is bound to get more spirit than the law allows. Meanwhile it is scarcely accurate to term ginger beers, etc., non-alcoholic.

Alcohol Deodorizer.—

Alcohol	160	ounces
Powdered quicklime	300	grains
Powdered alum	150	grains
Spirit of nitrous ether	1¼	drachms

Mix the lime and alum intimately by trituration; add the alcohol and shake well; then add the spirit of nitrous ether; set aside for 7 days and filter through animal charcoal.

Denaturized Alcohol.—There are two general classes or degrees of denaturizing, viz., the "complete" and the "incomplete," according to the purpose for

which the alcohol so denaturized is to be ultimately used.

I.—Complete denaturization by the German system is accomplished by the addition to every 100 liters (equal to 26½ gallons) of spirits:

(*a*) Two and one-half liters of the "standard" denaturizer, made of 4 parts of wood alcohol, 1 part of pyridine (a nitrogenous base obtained by distilling bone oil or coal tar), with the addition of 50 grams to each liter of oil of lavender or rosemary.

(*b*) One and one-fourth liters of the above "standard" and 2 liters of benzol with every 100 liters of alcohol.

II.—Incomplete denaturization—i. e., sufficient to prevent alcohol from being drunk, but not to disqualify it from use for various special purposes, for which the wholly denaturized spirits would be unavailable—is accomplished by several methods as follows, the quantity and nature of each substance given being the prescribed dose for each 100 liters (26½ gallons) of spirits:

(*c*) Five liters of wood alcohol or ½ liter of pyridine.

(*d*) Twenty liters of solution of shellac, containing 1 part gum to 2 parts alcohol of 90-per-cent purity. Alcohol for the manufacture of celluloid and pegamoid is denaturized.

(*e*) By the addition of 1 kilogram of camphor or 2 liters oil of turpentine or ½ liter benzol to each 100 liters of spirits. Alcohol to be used in the manufacture of ethers, aldehyde, agaricin, white lead, bromo-silver gelatines, photographic papers and plates, electrode plates, collodion, salicylic acid and salts, aniline chemistry, and a great number of other purposes, is denaturized by the addition of—

(*f*) Ten liters sulphuric ether, or 1 part of benzol, or ½ part oil of turpentine, or 0.025 part of animal oil.

For the manufacture of varnishes and inks alcohol is denaturized by the addition of oil of turpentine or animal oil, and for the production of soda soaps by the addition of 1 kilogram of castor oil. Alcohol for the production of lanolin is prepared by adding 5 liters of benzine to each hectoliter of spirits.

ALE.

The ale of the modern brewer is manufactured in several varieties, which are determined by the wants of the consumer and the particular market for which it is intended. Thus, the finer kinds of Burton, East India, Bavarian, and other like ales, having undergone a thorough fermentation, contain only a small quantity of undecomposed sugar and gum, varying from 1 to 5 per cent. Some of these are highly "hopped" or "bittered," the further to promote their preservation during transit and change of temperature. Mild or sweet ales, on the contrary, are less accentuated by lengthened fermentation, and abound in saccharine and gummy matter. They are, therefore, more nutritious, though less intoxicating, than those previously referred to.

In brewing the finer kinds of ales, pale malt and the best hops of the current season's growth are always employed; and when it is desired to produce a liquor possessing little color, very great attention is paid to their selection. With the same object, the boiling is conducted with more than the usual precautions, and the fermentation is carried on at a somewhat lower temperature than that commonly allowed for other varieties of beer. For ordinary ale, intended for immediate use, the malt may be all pale; but, if the liquor be brewed for keeping, and in warm weather, when a slight color is not objectionable, one-fifth, or even one-fourth of amber malt may be advantageously employed. From 4½ to 6 pounds of hops is the quantity commonly used to the one-fourth of malt, for ordinary ales; and 7 pounds to 10 pounds for "keeping" ales. The proportions, however, must greatly depend on the intended quality and description of the brewing and the period that will be allowed for its maturation.

The stronger varieties of ale usually contain from 6 to 8 per cent of "absolute alcohol"; ordinary strong ale, 4½ to 6 per cent; mild ale, 3 to 4 per cent; and table ale, 1 to 1½ per cent (each by volume); together with some undecomposed saccharine, gummy, and extractive matter, the bitter and narcotic principles of the hop, some acetic acid formed by the oxidation of the alcohol, and very small and variable quantities of mineral and saline matter.

Ordinary ale-wort (preferably pale), sufficient to produce 1 barrel, is slowly boiled with about 3 handfuls of hops, and 12 to 14 pounds of crushed groats, until the whole of the soluble matter of the latter is extracted. The resulting liquor, after being run through a coarse strainer and become lukewarm, is fermented with 2 or 3 pints of yeast; and, as soon as the fermentation is at its height, is either closely bunged up for draft or is at once put into strong stoneware bottles, which are then well corked and wired.

White ale is said to be very nutritious, though apt to prove laxative to those un-

accustomed to its use. It is drunk in a state of effervescence or lively fermentation; the glass or cup containing it being kept in constant motion, when removed from the mouth, until the whole is consumed, in order that the thicker portion may not subside to the bottom.

ALE, GINGER:
See Beverages.

ALFENIDE METAL:
See Alloys.

ALKALI, HOW TO DETECT:
See Soaps.

ALKALOIDS, ANTIDOTES TO:
See Atropine.

Alloys

No general rules can be given for alloying metals. Alloys differing greatly in fusibility are commonly made by adding the more fusible ones, either in the melted state or in small portions at a time, to the other melted or heated to the lowest possible temperature at which a perfect union will take place between them. The mixture is usually effected under a flux, or some material that will promote liquefaction and prevent volatilization and unnecessary exposure to the air. Thus, in melting lead and tin together for solder, rosin or tallow is thrown upon the surface is rubbed with sal ammoniac; and in combining some metals, powdered charcoal is used for the same purpose. Mercury or quicksilver combines with many metals in the cold, forming AMALGAMS, or easily fusible alloys (q. v.).

Alloys generally possess characteristics unshared by their component metals. Thus, copper and zinc form brass, which has a different density, hardness, and color from either of its constituents. Whether the metals tend to unite in atomic proportions or in any definite ratio is still undetermined. The evidence afforded by the natural alloys of gold and silver, and by the phenomena accompanying the cooling of several alloys from the state of fusion, goes far to prove that such is the case (Rudberg). The subject is, however, one of considerable difficulty, as metals and metallic compounds are generally soluble in each other, and unite by simple fusion and contact. That they do not combine indifferently with each other, but exercise a species of elective affinity not dissimilar to other bodies, is clearly shown by the homogeneity and superior quality of many alloys in which the constituent metals are in atomic proportion. The variation of the specific gravity and melting points of alloys from the mean of those of their component metals also affords strong evidence of a chemical change having taken place. Thus, alloys generally melt at lower temperatures than their separate metals. They also usually possess more tenacity and hardness than the mean of their constituents.

Matthiessen found that when weights are suspended to spirals of hard-drawn wire made of copper, gold, or platinum, they become nearly straightened when stretched by a moderate weight; but wires of equal dimensions composed of copper-tin (12 per cent of tin), silver-platinum (36 per cent of platinum), and gold-copper (84 per cent of copper) scarcely undergo any permanent change in form when subjected to tension by the same weight.

The same chemist gives the following approximate results upon the tenacity of certain metals and wires hard-drawn through the same gauge (No. 23):

	Pounds
Copper, breaking strain.........	25–30
Tin, breaking strain.......under	7
Lead, breaking strain......under	7
Tin-lead (20% lead).......about	7
Tin-copper (12% copper)...about	7
Copper-tin (12% tin)......about	80–90
Gold (12% tin)...............	20–25
Gold-copper (8.4% copper)......	70–75
Silver (8.4% copper)...........	45–50
Platinum (8.4% copper)........	45–50
Silver-platinum (30% platinum).	75–80

On the other hand, the malleability, ductility, and power of resisting oxygen of alloys is generally diminished. The alloy formed of two brittle metals is always brittle; that of a brittle and a ductile metal, generally so; and even two ductile metals sometimes unite to form a brittle compound. The alloys formed of metals having different fusing points are usually malleable while cold and brittle while hot. The action of the air on alloys is generally less than on their simple metals, unless the former are heated. A mixture of 1 part of tin and 3 parts of lead is scarcely acted on at common temperatures; but at a red heat it readily takes fire, and continues to burn for some time like a piece of bad turf. In like manner, a mixture of tin and zinc, when strongly heated, decomposes both moist air and steam with rapidity.

The specific gravity of alloys is rarely

the arithmetical mean of that of their constituents, as commonly taught; and in many cases considerable condensation or expansion occurs. When there is a strong affinity between two metals, the density of their alloy is generally greater than the calculated mean; and vice versa, as may be seen in the following table:

ALLOYS HAVING A DENSITY

Greater than the Mean of their Constituents:

Copper and bismuth,
Copper and palladium,
Copper and tin,
Copper and zinc,
Gold and antimony,
Gold and bismuth,
Gold and cobalt,
Gold and tin,
Gold and zinc,
Lead and antimony,
Palladium and bismuth,
Silver and antimony,
Silver and bismuth,
Silver and lead,
Silver and tin,
Silver and zinc.

Less than the Mean of their Constituents:

Gold and copper,
Gold and iridium,
Gold and iron,
Gold and lead,
Gold and nickel,
Gold and silver,
Iron and antimony,
Iron and bismuth,
Iron and lead,
Nickel and arsenic,
Silver and copper,
Tin and antimony,
Tin and lead,
Tin and palladium,
Zinc and antimony.

Compounding Alloys.—Considerable experience is necessary to insure success in compounding alloys, especially when the metals employed vary greatly in fusibility and volatility. The following are rules supplied by an experienced workman:

1. Melt the least fusible, oxidizable, and volatile first, and then add the others heated to their point of fusion or near it. Thus, if it is desired to make an alloy of exactly 1 part of copper and 3 of zinc, it will be impossible to do so by putting proportions of the metals in a crucible and exposing the whole to heat. Much of the zinc would fly off in vapor before the copper was melted. First, melt the copper and add the zinc, which has been melted in another crucible. The zinc should be in excess, as some of it will be lost anyway.

2. Some alloys, as copper and zinc, copper and arsenic, may be formed by exposing heated plates of the least fusible metal to the vapor of the other. In making brass in the large way, thin plates of copper are dissolved, as it were, in melted zinc until the proper proportions have been obtained.

3. The surface of all oxidizable metals should be covered with some protecting agent, as tallow for very fusible ones, rosin for lead and tin, charcoal for zinc, copper, etc.

4. Stir the metal before casting and if possible, when casting, with a white-wood stick; this is much better for the purpose than an iron rod.

5. If possible, add a small portion of old alloy to the new. If the alloy is required to make sharp castings and strength is not a very great object, the proportion of old alloy to the new should be increased. In all cases a new or thoroughly well-cleansed crucible should be used.

To obtain metals and metallic alloys from their compounds, such as oxides, sulphides, chlorides, etc., a process lately patented makes use of the reducing qualities of aluminum or its alloys with magnesium. The finely powdered material (e. g., chromic oxide) is placed in a crucible mixed with aluminum oxide. The mixture is set afire by means of a soldering pipe or a burning magnesium wire, and the desired reaction takes place. For igniting, one may also employ with advantage a special priming cartridge consisting of pulverized aluminum to which a little magnesium may be mixed, and peroxide of magnesia, which is shaped into balls and lighted with a magnesium wire. By suitable additions to the pulverized mixture, alloys containing aluminum, magnetism, chromium, manganese, copper, iron, boron, silicic acid, etc., are obtained.

ALUMINUM ALLOYS.

M. H. Pecheux has contributed to the *Comptes Rendus*, from time to time, the results of his investigations into the alloys of aluminum with soft metals, and the following constitutes a brief summary of his observations:

Lead.—When aluminum is melted and lead is added in proportion greater than 10 per cent, the metals separate on cooling into three layers—lead, aluminum, and between them an alloy containing from 90 to 97 per cent of aluminum.

The alloys with 93, 95, and 98 per cent have densities of 2.745, 2.674, and 2.600 respectively, and melting points near that of aluminum. Their color is like that of aluminum, but they are less lustrous. All are malleable, easily cut, softer than aluminum, and have a granular fracture. On remelting they become somewhat richer in lead, through a tendency to liquation. They do not oxidize in moist air, nor at their melting points. They are attacked in the cold by hydrochloric and by strong sulphuric acid, with evolution of hydrogen, and by strong nitric acid when hot; strong solution of potassium hydroxide also attacks them. They are without action on distilled water, whether cold or hot.

Zinc.—Well-defined alloys were obtained, corresponding to the formulas Zn_3Al, Zn_2Al, $ZnAl$, $ZnAl_2$, $ZnAl_3$, $ZnAl_4$, $ZnAl_6$, $ZnAl_{10}$, $ZnAl_{12}$. Their melting points and densities all lie between those of zinc and aluminum, and those containing most zinc are the hardest. They are all dissolved by cold hydrochloric acid and by hot dilute nitric acid. Cold concentrated nitric acid attacks the first three, and cold dilute acid the first five. The Zn_3Al, $ZnAl_6$, $ZnAl_{10}$, and $ZnAl_{12}$ are only slightly affected by cold potassium-hydroxide solution; the others are strongly attacked, potassium zincate and aluminate probably being formed.

Tin.—A filed rod of tin-aluminum alloy plunged in cold water gives off for some minutes bubbles of gas, composed of hydrogen and oxygen in explosive proportions. An unfiled rod, or a filed rod of either aluminum or tin, is without action, though the unfiled rod of alloy will act on boiling water. The filed rod of alloy, in faintly acid solution of copper or zinc sulphate, becomes covered with a deposit of copper or zinc, while bubbles of oxygen are given off. M. Pecheux believes that the metals are truly alloyed only at the surface, and that filing lays bare an almost infinitely numerous series of junctions of the two metals, which, heated by the filing, act as thermocouples.

Bismuth.—By the method used for lead, bismuth alloys were obtained containing 75, 85, 88, and 94 per cent of aluminum, with densities 2.86, 2.79, 2.78, and 2.74 respectively. They were sonorous, brittle, finely grained, and homogeneous, silver-white, and with melting points between those of their constituents, but nearer that of aluminum. They are not oxidized in air at the temperature of casting, but are readily attacked by acids, concentrated or dilute, and by potassium-hydroxide solution. The filed alloys behave like those of tin, but still more markedly.

Magnesium.—These were obtained with 66, 68, 73, 77, and 85 per cent of aluminum, and densities 2.24, 2.47, 2.32, 2.37, 2.47. They are brittle, with large granular fracture, silver-white, file well, take a good polish, and have melting points near that of aluminum. Being viscous when melted, they are difficult to cast, and when slowly cooled form a gray, spongy mass which cannot be remelted. They do not oxidize in air at the ordinary temperatures, but burn readily at a bright-red heat. They are attacked violently by acids and by potassium-hydroxide solution, decompose hydrogen peroxide, and slowly decompose water even in the cold.

Tin, Bismuth, and Magnesium.—The action of water on these alloys just referred to has been recently demonstrated on a larger scale, 5 to 6 cubic centimeters of hydrogen having been obtained in 20 minutes from 2 cubic centimeters of the filed tin alloy. The bismuth alloy yielded more hydrogen than the tin alloy, and the magnesium alloy more than the bismuth alloy. The oxygen of the decomposed water unites with the aluminum. Larger quantities of hydrogen are obtained from copper-sulphate solution, apart from the decomposition of this solution by precipitation of copper at the expense of the metal alloyed with the aluminum. The alloys of aluminum with zinc and lead do not decompose pure water, but do decompose the water of copper-sulphate solution, and, more slowly, that of zinc-sulphate solution.

Aluminum is a metal whose properties are very materially influenced by a proportionately small addition of copper. Alloys of 99 per cent aluminum and 1 per cent of copper are hard, brittle, and bluish in color; 95 per cent of aluminum and 5 per cent of copper give an alloy which can be hammered, but with 10 per cent of copper the metal can no longer be worked. With 80 per cent and upward of copper are obtained alloys of a beautiful yellow color, and these mixtures, containing from 5 to 10 per cent of aluminum and from 90 to 95 per cent of copper, are the genuine aluminum bronzes. The 10-per-cent alloys are of a pure golden-yellow color; with 5 per cent of aluminum they are reddish yellow, like gold heavily alloyed with copper, and a 2-per-cent admixture is of an almost pure copper red

As the proportion of copper increases, the brittleness is diminished, and alloys containing 10 per cent and less of aluminum can be used for industrial purposes, the best consisting of 90 per cent of copper and 10 of aluminum. The hardness of this alloy approaches that of the general bronzes, whence its name. It can be stretched out into thin sheets between rollers, worked under the hammer, and shaped as desired by beating or pressure, in powerful stamping presses. On account of its hardness it takes a fine polish, and its peculiar greenish-gold color resembles that of gold alloyed with copper and silver together.

Alloys with a still greater proportion of copper approach this metal more and more nearly in their character; the color of an alloy, for instance, composed of 95 per cent of copper and 5 per cent of aluminum, can be distinguished from pure gold only by direct comparison, and the metal is very hard, and also very malleable.

Electrical Conductivity of Aluminum Alloys.—During three years' exposure to the atmosphere, copper-aluminum alloys in one test gradually diminished in conductivity in proportion to the amount of copper they contained. The nickel-copper aluminum alloys, which show such remarkably increased tensile strength as compared with good commercial aluminum, considerably diminished in total conductivity. On the other hand, the manganese-copper aluminum alloys suffered comparatively little diminution in total conductivity, and one of them retained comparatively high tensile strength. It was thought that an examination of the structure of these alloys by aid of microphotography might throw some light on the great difference which exists between some of their physical properties. For instance, a nickel-copper aluminum alloy has 1.6 times the tensile strength of ordinary commercial aluminum. Under a magnification of 800 diameters practically no structure could be discovered. Considering the remarkable crystalline structure exhibited by ordinary commercial aluminum near the surface of an ingot, when allowed to solidify at an ordinary rate, the want of structure in these alloys must be attributed to the process of drawing down. The inference is that the great difference which exists between their tensile strengths and other qualities is not due to variation in structure.

Colored Alloys of Aluminum.—A purple scintillating composition is produced by an alloyage of 78 parts of gold and 22 parts aluminum. With platinum a gold-colored alloy is obtained; with palladium a copper-colored one; and with cobalt and nickel one of a yellow color. Easily fusible metals of the color of aluminum give white alloys. Metal difficult of fusion, such as iridium, osmium, titanium, etc., appear in abnormal tones of color through such alloyages.

Aluminum-Brass.—Aluminum, 1 per cent; specific gravity, 8.35; tensile strength, 40. Aluminum, 3 per cent; specific gravity, 8.33; tensile strength, 65. The last named is harder than the first.

Aluminum-Copper.—Minikin is principally aluminum with a small percentage of copper and nickel. It is alloyed by mixing the aluminum and copper, then adding the nickel. It resembles palladium and is very strong.

Aluminum-Silver.—I.—Silver, 3 per cent; aluminum, 97 per cent. A handsome color.

II.—A silver aluminum that is easily worked into various articles contains about one-fourth silver and three-fourths of aluminum.

Aluminum-Tin.—Bourbon metal is composed of equal parts of aluminum and tin; it solders readily.

Aluminum-Tungsten.—A new metal alloy consisting of aluminum and tungsten is used of late in France in the construction of conveyances, especially carriages, bicycles, and motor vehicles. The French call it partinium; the composition of the new alloy varies according to the purposes for which it is used. It is considerably cheaper than aluminum, almost as light, and has a greater resistance. The strength is stated at 32 to 37 kilograms per square millimeter.

Aluminum-Zinc.—Zinc, 3 per cent; aluminum, 97 per cent. Very ductile, white, and harder than aluminum.

AMALGAMS:

See Fusible Alloys.

Anti-Friction Bearing or Babbitt Metals.—These alloys are usually supported by bearings of brass, into which it is poured after they have been tinned, and heated and put together with an exact model of the axle, or other working piece, plastic clay being previously applied, in the usual manner, as a lute or outer mold. Soft gun metal is also excellent, and is much used for bearings. They all become less heated in working than the

harder metals, and less grease or oil is consequently required when they are used.

I.—An anti-friction metal of excellent quality and one that has been used with success is made as follows: 17 parts zinc; 1 part copper; 1½ parts antimony; prepared in the following way: Melt the copper in a small crucible, then add the antimony, and lastly the zinc, care being taken not to burn the zinc. Burning can be prevented by allowing the copper and antimony to cool slightly before adding the zinc. This metal is preferably cast into the shape desired and is not used as a lining metal because it requires too great a heat to pour. It machines nicely and takes a fine polish on bearing surfaces. It has the appearance of aluminum when finished. Use a lubricating oil made from any good grade of machine oil to which 3 parts of kerosene have been added.

II.—Copper, 6 parts; tin, 12 parts; lead, 150 parts; antimony, 30 parts; wrought iron, 1 part; cast iron, 1 part. For certain purposes the composition is modified as follows: Copper, 16 parts; tin, 40 parts; lead, 120 parts; antimony, 24 parts; wrought iron, 1 part; cast iron, 1 part. In both cases the wrought iron is cut up in small pieces, and in this state it will melt readily in fused copper and cast iron. After the mixture has been well stirred, the tin, lead, and antimony are added; these are previously melted in separate crucibles, and when mingled the whole mass is again stirred thoroughly. The product may then be run into ingots, to be employed when needed. When run into the molds the surface should be well skimmed, for in this state it oxidizes rapidly. The proportions may be varied without materially affecting the results.

III.—From tin, 16 to 20 parts; antimony, 2 parts; lead, 1 part; fused together, and then blended with copper, 80 parts. Used where there is much friction or high velocity.

IV.—Zinc, 6 parts; tin, 1 part; copper, 20 parts. Used when the metal is exposed to violent shocks.

V.—Lead, 1 part; tin, 2 parts; zinc, 4 parts; copper, 68 parts. Used when the metal is exposed to heat.

VI.—Tin, 48 to 50 parts; antimony, 5 parts; copper, 1 part.

VII.—(Fenton's.) Tin, with some zinc, and a little copper.

VIII.—(Ordinary.) Tin, or hard pewter, with or without a small portion of antimony or copper. Without the last it is apt to spread out under the weight of heavy machinery. Used for the bearings of locomotives, etc.

The following two compositions are for motor and dynamo shafts: 100 pounds tin; 10 pounds copper; 10 pounds antimony.

83⅓ pounds tin; 8⅓ pounds antimony; 8⅓ pounds copper.

IX.—Lead, 75 parts; antimony, 23 parts; tin, 2 parts.

X.—Magnolia Metal.—This is composed of 40 parts of lead, 7½ parts of antimony, 2½ of tin, ⅛ of bismuth, ⅛ of aluminum, and ¼ of graphite. It is used as an anti-friction metal, and takes its name from its manufacturer's mark, a magnolia flower.

ARGENTAN:

See German Silver, under this title.

BELL METAL.

The composition of bell metal varies considerably, as may be seen below:

I.—(Standard.) Copper, 78 parts; tin, 22 parts; fused together and cast. The most sonorous of all the alloys of copper and tin. It is easily fusible, and has a fine compact grain, and a vitreous conchoidal and yellowish-red fracture. According to Klaproth, the finest-toned Indian gongs have this composition.

II.—(Founder's Standard.) Copper, 77 parts; tin, 21 parts; antimony, 2 parts. Slightly paler and inferior to No. I.

III.—Copper, 80 parts; tin, 20 parts. Very deep-toned and sonorous. Used in China and India for the larger gongs, tam-tams, etc.

IV.—Copper, 78 to 80 parts; tin, 22 to 20 parts. Usual composition of Chinese cymbals, tam-tams, etc.

V.—Copper, 75 (= 3) parts; tin, 25 (=1) part. Somewhat brittle. In fracture, semivitreous and bluish-red. Used for church and other large bells.

VI.—Copper, 80 parts; tin, 10¼ parts; zinc, 5½ parts; lead, 4¼ parts. English bell metal, according to Thomson. Inferior to the last; the lead being apt to form isolated drops, to the injury of the uniformity of the alloy.

VII.—Copper, 68 parts; tin, 32 parts. Brittle; fracture conchoidal and ash-gray. Best proportions for house bells, hand bells, etc.; for which, however, 2 of copper and 1 of tin is commonly substituted by the founders.

VIII.—Copper, 72 parts; tin, 26½ parts; iron, 1½ parts. Used by the Paris houses for the bells of small clocks.

IX.—Copper, 72 parts; tin, 26 parts; zinc, 2 parts. Used, like the last, for very small bells.

X.—Copper, 70 parts; tin, 26 parts;

zinc, 2 parts. Used for the bells of repeating watches.

XI.—Melt together copper, 100 parts; tin, 25 parts. After being cast into the required object, it should be made red-hot, and then plunged immediately into cold water in order to impart to it the requisite degree of sonorousness. For cymbals and gongs.

XII.—Melt together copper, 80 parts; tin, 20 parts. When cold it has to be hammered out with frequent annealing.

XIII.—Copper, 78 parts; tin, 22 parts; This is superior to the former, and it can be rolled out. For tam-tams and gongs.

XIV.—Melt together copper, 72 parts; tin, 26 to 56 parts; iron 1/4 part. Used in making the bells of ornamental French clocks.

Castings in bell metal are all more or less brittle; and, when recent, have a color varying from a dark ash-gray to grayish-white, which is darkest in the more cuprous varieties, in which it turns somewhat on the yellowish-red or bluish-red. The larger the proportion of copper in the alloy, the deeper and graver the tone of the bells formed of it. The addition of tin, iron, or zinc, causes them to give out their tones sharper. Bismuth and lead are also often used to modify the tone, which each metal affects differently. The addition of antimony and bismuth is frequently made by the founder to give a more crystalline grain to the alloy. All these conditions are, however, prejudicial to the sonorousness of bells, and of very doubtful utility. Rapid refrigeration increases the sonorousness of all these alloys. Hence M. D'Arcet recommends that the "pieces" be heated to a cherry-red after they are cast, and after having been suddenly plunged into cold water, that they be submitted to well-regulated pressure by skillful hammering, until they assume their proper form; after which they are to be again heated and allowed to cool slowly in the air. This is the method adopted by the Chinese with their gongs, etc., a casing of sheet iron being employed by them to support and protect the pieces during the exposure to heat. In a general way, however, bells are formed and completed by simple casting. This is necessarily the case with all very large bells. Where the quality of their tones is the chief object sought after, the greatest care should be taken to use commercially pure copper. The presence of a very little lead or any similar metal greatly lessens the sonorousness of this alloy; while that of silver increases it.

The specific gravity of a large bell is seldom uniform through its whole substance; nor can the specific gravity from any given portion of its constituent metals be exactly calculated owing to the many interfering circumstances. The nearer this uniformity is approached, or, in other words, chemical combination is complete, the more durable and finer-toned will be the bell. In general, it is found necessary to take about one-tenth more metal than the weight of the intended bell, or bells, in order to allow for waste and scorification during the operations of fusing and casting.

BISMUTH ALLOYS.

Bismuth possesses the unusual quality of expanding in cooling. It is, therefore, introduced in many alloys to reduce or check shrinkage in the mold.

For delicate castings, and for taking impressions from dies, medals, etc., various bismuth alloys are in use, whose composition corresponds to the following figures:

	I	II	III	IV
Bismuth	6	5	2	8
Tin	3	2	1	3
Lead	13	3	1	5

V.—Cliché Metal.—This alloy is composed of tin, 48 parts; lead, 32.5; bismuth, 9; and antimony, 10.5. It is especially well adapted to dabbing rollers for printing cotton goods, and as it possesses a considerable degree of hardness, it wears well.

VI.—For filling out defective places in metallic castings, an alloy of bismuth 1 part, antimony 3, lead 8, can be advantageously used.

VII.—For Cementing Glass.—Most of the cements in ordinary use are dissolved, or at least softened, by petroleum. An alloy of lead 3 parts, tin 2, bismuth 2.5, melting at 212° F., is not affected by petroleum, and is therefore very useful for cementing lamps made of metal and glass combined.

LIPOWITZ'S BISMUTH ALLOY:

See Cadmium Alloys.

BRASS.

In general brass is composed of two-thirds copper and one-third zinc, but a little lead or tin is sometimes advantageous, as the following:

I.—Red copper, 66 parts; zinc, 34 parts; lead, 1 part.

II.—Copper, 66 parts; zinc, 32 parts; tin, 1 part; lead, 1 part.

III.—Copper, 64.5 parts; zinc, 33.5 parts; lead, 1.5 parts; tin, 0.5 part.

Brass-Aluminum.—A small addition of aluminum to brass (1.5 to 8 per cent) great-

ly increases its hardness and elasticity, and this alloy is also easily worked for any purpose. Brass containing 8 per cent of aluminum has the valuable property of being but slightly affected by acids or gases. A larger percentage of aluminum makes the brass brittle. It is to be noted that aluminum brass decreases very materially in volume in casting, and the casts must be cooled slowly or they will be brittle. It is an alloy easily made, and its low price, combined with its excellent qualities, would seem to make it in many cases an advantageous substitute for the expensive phosphorous bronze.

Bristol Brass (Prince's Metal).—This alloy, which possesses properties similar to those of French brass, is prepared in the following proportions:

	I	II	III
Copper............	75.7	67.2	60.8
Zinc..............	24.3	32.8	39.2

Particular care is required to prevent the zinc from evaporating during the fusing, and for this purpose it is customary to put only half of it into the first melting, and to add the remainder when the first mass is liquefied.

Brass-Iron (Aich's Metal).—This is a variety of brass with an admixture of iron, which gives it a considerable degree of tenacity. It is especially adapted for purposes which require a hard and, at the same time, tenacious metal. Analyses of the various kinds of this metal show considerable variation in the proportions. Even the amount of iron, to which the hardening effect must be attributed, may vary within wide limits without materially modifying the tenacity which is the essential characteristic of this alloy.

I.—The best variety of Aich's metal consists of copper, 60 parts; zinc, 38.2; iron, 1.8. The predominating quality of this alloy is its hardness, which is claimed to be not inferior to that of certain kinds of steel. It has a beautiful golden-yellow color, and is said not to oxidize easily, a valuable property for articles exposed to the action of air and water.

II.—Copper, 60.2 parts; zinc, 38.2; iron, 1.6. The permissible variations in the content of iron are from 0.4 to 3 per cent.

Sterro metal may properly be considered in connection with Aich's metal, since its constituents are the same and its properties very similar. The principal difference between the two metals is that sterro metal contains a much larger amount of iron. The composition of this alloy varies considerably with different manufacturers.

III.—Two varieties of excellent quality are the product of the Rosthorn factory, in Lower Austria—copper, 55.33 parts; zinc, 41.80; iron, 4.66. Also

IV.—English sterro metal (Gedge's alloy for ship sheathing), copper, 60 parts; zinc, 38.125; iron, 1.5.

The great value of this alloy lies in its strength, which is equaled only by that of the best steel. As an illustration of this, a wrought-iron pipe broke with a pressure of 267 atmospheres, while a similar pipe of sterro metal withstood the enormous pressure of 763 atmospheres without cracking. Besides its remarkable strength, it possesses a high degree of elasticity, and is, therefore, particularly suitable for purposes which require the combination of these two qualities, such as the construction of hydraulic cylinders. It is well known that these cylinders, at a certain pressure, begin to sweat, that is, the interior pressure is so great that the water permeates through the pores of the steel. With a sterro metal cylinder, the pressure can be considerably increased without any moisture being perceptible on the outside of the cylinder.

Sterro metal can be made even more hard and dense, if required for special purposes, but this is effected rather by mechanical manipulation than by any change in the chemical composition. If rolled or hammered in heat, its strength is increased, and it acquires, in addition, an exceedingly high degree of tenacity. Special care must be taken, however, in hammering not to overheat the metal, as in this case it would become brittle and might crack under the hammer. Sterro metal is especially suitable for all the purposes for which the so-called red metal has been in the past almost exclusively used. Axle bearings, for example, made of sterro metal have such excellent qualities that many machine factories are now using this material entirely for the purpose.

Cast Brass.—The various articles of bronze, so called, statuettes, clock cases, etc., made in France, where this industry has attained great perfection and extensive proportions, are not, in many cases, genuine bronze, but fine cast brass. Following are the compositions of a few mixtures of metals most frequently used by French manufacturers:

	Copper	Zinc	Tin	Lead
I.......	63.70	33.55	2.50	0.25
II.......	64.45	32.44	0.25	2.86
III.......	70.90	24.05	2.00	3.05
IV.......	72.43	22.75	1.87	2.95

Their special advantage is that they can be readily cast, worked with file and chisel, and easily gilded.

To Cast Yellow Brass.—If good, clean, yellow brass sand castings are desired, the brass should not contain over 30 per cent of zinc. This will assure an alloy of good color and one which will run free and clean. Tin or lead may be added without affecting the property of casting clean. A mixture of 7 pounds of copper, 3 pounds of spelter, 4 ounces of tin, and 3 ounces of lead makes a good casting alloy and one which will cut free and is strong. If a stronger alloy be desired, more tin may be added, but 4 ounces is usually sufficient. If the alloy be too hard, reduce the proportion of tin.

Leaf Brass.—This alloy is also called Dutch gold, or imitation gold leaf. It is made of copper, 77.75 to 84.5 parts; zinc, 15.5 to 22.25. Its color is pale or bright yellow or greenish, according to the proportions of the metals. It has an unusual degree of ductility.

Malleable Brass.—This metal is affected less by sea water than pure copper, and was formerly much used for ship sheathing, and for making nails and rivets which were to come in contact with sea water. At the present day it has lost much of its importance, since all the larger ships are made of steel. It is usually composed of copper, 60 to 62 parts; and zinc, 40 to 38 parts. It is sometimes called yellow metal, or Müntz metal (called after its inventor), and is prepared with certain precautions, directed toward obtaining as fine a grain as possible, experience having shown that only a fine-grained alloy of uniform density can resist the action of the sea water evenly. A metal of uneven density will wear in holes. To obtain as uniform a grain as possible, small samples taken from the fused mass are cooled quickly and examined as to fracture. If they do not show the desired uniform grain, some zinc is added to the mass. After it has permeated the whole mass, a fresh sample is taken and tested, this being continued until the desired result is reached. It is scarcely necessary to remark that considerable experience is required to tell the correct composition of the alloy from the fracture. The mass is finally poured into molds and rolled cold. Malleable brass can be worked warm, like iron, being ductile in heat, a valuable quality.

Experiments with malleable brass show that all alloys containing up to 58.33 per cent of copper and up to 41.67 per cent of zinc are malleable. There is, in addition, a second group of such alloys, with 61.54 per cent of copper and 38.46 per cent of zinc, which are also malleable in heat.

The preparation of these alloys requires considerable experience, and is best accomplished by melting the metals together in the usual manner, and heating the fused mass as strongly as possible. It must be covered with a layer of charcoal dust to prevent oxidation of the zinc. The mass becomes thinly fluid, and an intimate mixture of the constituents is effected. Small pieces of the same alloy are thrown into the liquid mass until it no longer shows a reflecting surface, when it is cast into ingots in iron molds. The ingots are plunged into water while still red-hot, and acquire by this treatment a very high degree of ductility. The alloy, properly prepared, has a fibrous fracture and a reddish-yellow color.

Sheet Brass (For Sheet and Wire).—In the preparation of brass for the manufacture of wire, an especially pure quality of copper must be used; without this, all efforts to produce a suitable quality of brass will be in vain. That pure copper is indispensable to the manufacture of good, ductile brass may be seen from the great difference in the composition of the various kinds, all of which answer their purpose, but contain widely varying quantities of copper and zinc. The following table shows the composition of some excellent qualities of brass suitable for making sheet and wire:

Brass Sheet—Source	Copper	Zinc	Lead	Tin
Jemappes	64.6	33.7	1.4	0.2
Stolberg	64.8	32.8	2.0	0.4
Romilly	70.1	29.26	0.38	0.17
Rosthorn (Vienna)	68.1	31.9	....	....
Rosthorn (Vienna)	71.5	28.5	....	....
Rosthorn (Vienna)	71.1	27.6	1.3	....
Iserlohn & Romilly	70.1	29.9	....	....
Lüdenscheid	72.73	27.27	....	....
(Brittle)	63.66	33.02	2.52	....
Hegermühl	70.16	27.45	0.79	0.20
Oker	68.98	29.54	0.97	....
Brass Wire—				
England	70.29	29.26	0.28	0.17
Augsburg	71.89	27.63	0.85	....
Neustadt	70.16	27.45	0.2	0.79
Neustadt	71.36	28.15	....	....
Neustadt	71.5	28.5	....	....
Neustadt	71.0	27.6	....	....
(Good quality)	65.4	34.6	....	....
(Brittle)	65.5	32.4	2.1	....
For wire and sheet	67.0	32.0	0.5	0.5

As the above figures show, the percentage of zinc in the different kinds of brass lies between 27 and 34. Recently, alloys containing a somewhat larger quantity of zinc have been used, it having been found that the toughness and ductility of the brass are increased thereby, without injury to its tenacity. Alloys containing up to 37 per cent of zinc possess a high degree of ductility in the cold, and are well adapted for wire and sheet.

Gilders' Sheet Brass.—Copper, 1 part; zinc, 1 part; tin, $\frac{1}{10}$ part; lead, $\frac{1}{10}$ part. Very readily fusible and very dense.

White Brass.—Birmingham platina is an alloy of a pure white, almost silver-white color, remaining unaffected by tolerably long exposure to the atmosphere. Unfortunately this alloy is so brittle that it can rarely be shaped except by casting. It is used only in the manufacture of buttons. The alloy is poured into molds giving rather sharp impressions and allowing the design on the button (letters or coat of arms) to stand out prominently with careful stamping. The composition of this alloy, also known by the name of platinum lead, is as follows:

	I	II
Copper	46.5	4
Zinc	53.5	16

III.—Zinc, 80 parts; copper, 10 parts; iron, 10 parts.

BRITANNIA METAL.

Britannia metal is an alloy consisting principally of tin and antimony. Many varieties contain only these two metals, and may be considered simply as tin hardened with antimony, while others contain, in addition, certain quantities of copper, sometimes lead, and occasionally, though rarely on account of its cost, bismuth. Britannia metal is always of a silvery-white color, with a bluish tinge, and its hardness makes it capable of taking a high polish, which is not lost through exposure to the air. Ninety per cent of tin and 10 per cent of antimony gives a composition which is the best for many purposes, especially for casting, as it fills out the molds well, and is readily fusible. In some cases, where articles made from it are to be subjected to constant wear, a harder alloy is required. In the proportions given above, the metal is indeed much harder than tin, but would still soon give way under usage.

A table is appended, giving the composition of some of the varieties of Britannia metal and their special names.

	Tin	Antimony	Copper	Zinc	Lead
English	81.90	16.25	1.84	....	....
English	90.62	7.81	1.46	....	....
English	90.1	6.3	3.1	0.5	....
English	85.4	9.66	0.81	3.06	....
Pewter	81.2	5.7	1.60	....	11.5
Pewter	89.3	7.6	1.8	....	1.8
Tutania	91.4	....	0.7	0.3	7.6
Queen's metal	88.5	7.1	3.5	0.9	....
German	72.0	24.0	4.0	....	....
German	84.0	9.0	2.0	5.0	....
German (for casting)	20.0	64.0	10.0	6.0	....
Malleable (for casting)	48.0	....	3.0	48.0	1.0

Britannia metal is prepared by melting the copper alone first, then adding a part of the tin and the whole of the antimony. The heat can then be quickly moderated, as the melting point of the new alloy is much lower than that of copper. Finally, the rest of the tin is added, and the mixture stirred constantly for some time to make it thoroughly homogeneous.

An alloy which bears a resemblance to Britannia metal is Ashberry metal, for which there are two formulas.

	I	II
Copper	2	3
Tin	8	79
Antimony	14	15
Zinc	1	2
Nickel	2	1

BRONZES.

The composition of bronze must be effected immediately before the casting, for bronze cannot be kept in store ready prepared. In forming the alloy, the refractory compound, copper, is first melted separately, the other metals, tin, zinc, etc., previously heated, being then added; the whole is then stirred and the casting carried out without loss of time. The process of forming the alloy must be effected quickly, so that there may be no loss of zinc, tin, or lead through oxidation, and also no interruption to the flow of metal, as metal added after an interval of time will not combine perfectly with the metal already poured in. It is important, therefore, to ascertain the specific weights of the metals, for the heavier metal will naturally tend to sink to the bottom and the lighter to collect at the top. Only in this way, and by vigorous stirring, can the complete blending of the two metals be secured. In adding the zinc, great care

must be taken that the latter sinks at once to the level of the copper, otherwise a considerable portion will be volatilized before reaching the copper. When the castings are made, they must be cooled as quickly as possible, for the components of bronze have a tendency to form separate alloys of various composition, thus producing the so-called tin spots. This is much more likely to occur with a slow than with a sudden cooling of the mass.

Annealing Bronze.—This process is more particularly employed in the preparation of alloys used in the manufacture of cymbals, gongs, bells, etc. The alloy is naturally brittle, and acquires the properties essential to the purpose for which it is intended only after casting. The instruments are plunged into cold water while red-hot, hammered, reheated, and slowly cooled, when they become soft and sonorous. The alloy of copper and tin has the peculiar property that, whereas steel becomes hard through cooling, this mixture, when cooled suddenly, becomes noticeably soft and more malleable. The alloy is heated to a dark-red heat, or, in the case of thin articles, to the melting point of lead, and then plunged in cold water. The alloy may be hammered without splitting or breaking.

Aluminum Bronze.—This is prepared by melting the finest copper in a crucible, and adding the aluminum. The copper is cooled thereby to the thickly fluid point, but at the moment of the combination of the two metals, so much heat is released that the alloy becomes white hot and thinly fluid. Aluminum bronze thus prepared is usually brittle, and acquires its best qualities only after having been remelted several times. It may be remarked that, in order to obtain a bronze of the best quality, only the very purest copper must be used; with an inferior quality of copper, all labor is wasted. Aluminum bronze is not affected by exposure to the air; and its beautiful color makes it very suitable for manufacturing various ornamental articles, including clock cases, door knobs, etc.

Aluminum bronze wire is almost as strong as good steel wire, and castings made from it are almost as hard as steely iron; its resistance to bending or sagging is great.

I.—A good formula is 90 to 95 per cent of aluminum and 5 to 10 per cent of copper, of golden color, which keeps well in the air, without soon becoming dull and changing color like pure copper and its alloys with tin and zinc (bronze, brass, etc.). It can be cast excellently, can be filed well and turned, possesses an extraordinary hardness and firmness, and attains a high degree of polish; it is malleable and forgeable. On the latter quality are founded applications which were formerly never thought of, viz.: forged works of art for decorative purposes. An alloy of 95 parts aluminum and 5 parts copper is used here. The technical working of bronze is not materially different from that of iron. The metal, especially in a hot condition, is worked like iron on the anvil, with hammer and chisel, only that the temperature to be maintained in forging lies between dark and light cherry red. If the articles are not forged in one piece and the putting together of the separate parts becomes necessary, riveting or soldering has to be resorted to. Besides forging, aluminum bronze is well suited for embossing, which is not surprising considering the high percentage of copper. After finishing the pieces, the metal can be toned in manifold ways by treatment with acid.

II.—Copper, 89 to 98 per cent; aluminum and nickel, 1 to 2 per cent. Aluminum and nickel change in the opposite way, that is to say, in increasing the percentage of nickel the amount of aluminum is decreased by the equal quantity. It should be borne in mind that the best ratio is aluminum, 9.5 per cent; nickel, 1 to 1.5 per cent at most. In preparing the alloy a deoxidizing agent is added, viz., phosphorus to 0.5 per cent; magnesium to 1.5 per cent. The phosphorus should always be added in the form of phosphorous copper or phosphor aluminum of exactly determined percentage. It is first added to the copper, then the aluminum and the nickel, and finally the magnesium, the last named at the moment of liquidity, are admixed.

III.—A gold bronze, containing 3 to 5 per cent aluminum; specific gravity, 8.37 to 8.15. Handsome golden color. This alloy oxidizes less on heating than copper and iron, and is therefore especially adapted for locomotive fireboxes and spindles, etc.

IV.—A steel bronze containing on an average 8.5 per cent aluminum (including 1 per cent silicium); specific gravity, 7.7. Very ductile and tough, but slightly elastic; hence its use is excluded where, with large demands upon tension and pressure, no permanent change of form must ensue. This is changed by working, such as rolling, drawing, etc. Es-

pecially useful where infrangibility is desired, as in machinery, ordnance, etc. At high temperature this bronze loses its elasticity again.

V.—This contains 8.5 per cent aluminum and 1½ to 2 per cent silicium. Its use is advisable in cases where the metal is to possess a good elasticity, even in the cast state, and to retain it after being worked in red heat.

VI.—An acid bronze, containing 10 per cent aluminum; specific gravity, 7.65. Especially serviceable to resist oxidation and the action of acids.

VII.—Diamond bronze, containing 10 per cent aluminum and 2 per cent silicium. Specific gravity, 7.3. Very hard; of great firmness, but brittle.

Art Bronzes. (See also Aluminum Bronzes and Japanese Bronzes under this title.)—I.—Copper, 84 parts; zinc, 11 parts; tin, 5 parts.

II.—Copper, 90 parts; zinc, 6 parts; tin, 2 parts; lead, 2 parts.

III.—Copper, 65 parts; zinc, 30 parts; tin, 5 parts.

IV.—Copper, 90 parts; tin, 5 parts; zinc, 4 parts; lead, 1 part.

V.—Copper, 85 parts; zinc, 10 parts; tin, 3 parts; lead, 2 parts.

VI.—Copper, 72 parts; zinc, 23 parts; tin, 3 parts; lead, 2 parts.

Statuary Bronze.—Many of the antique statues were made of genuine bronze, which has advantages for this purpose, but has been superseded in modern times by mixtures of metals containing, besides copper and tin—the constituents of real bronze—a quantity of zinc, the alloy thus formed being really an intermediate product between bronze and brass. The reason for the use of such mixtures lies partly in the comparative cheapness of their production as compared with genuine bronze, and partly in the purpose for which the metal is to be used. A thoroughly good statuary bronze must become thinly fluid in fusing, fill the molds out sharply, allow of being easily worked with the file, and must take on the beautiful green coating called patina, after being exposed to the air for a short time.

Genuine bronze, however strongly heated, does not become thin enough to fill out the molds well, and it is also difficult to obtain homogeneous castings from it. Brass alone is also too thickly fluid, and not hard enough for the required fine chiseling or chasing of the finished object. Alloys containing zinc and tin, in addition to copper, can be prepared in such a manner that they will become very thinly fluid, and will give fine castings which can easily be worked with the file and chisel. The best proportions seem to be from 10 to 18 per cent of zinc and from 2 to 4 per cent of tin. In point of hardness, statuary bronze holds an intermediate position between genuine bronze and brass, being harder and tougher than the latter, but not so much so as the former.

Since statuary bronze is used principally for artistic purposes, much depends upon the color. This can be varied from pale yellow to orange yellow by slightly varying the content of tin or zinc, which must, of course, still be kept between the limits given above. Too much tin makes the alloy brittle and difficult to chisel; with too much zinc, on the other hand, the warm tone of color is lost, and the bronze does not acquire a fine patina.

The best proportions for statuary bronze are very definitely known at the present day; yet it sometimes happens that large castings have not the right character. They are either defective in color, or they do not take on a fine patina, or they are difficult to chisel. These phenomena may be due to the use of impure metals—containing oxides, iron, lead, etc.—or to improper treatment of the alloy in melting. With the most careful work possible, there is a considerable loss in melting—3 per cent at the very least, and sometimes as much as 10. This is due to the large proportion of zinc, and it is evident that, in consequence of it, the nature of the alloy will be different from what might be expected from the quantities of metals used in its manufacture.

It has been remarked that slight variations in composition quickly change the color of the alloy. The following table gives a series of alloys of different colors, suitable for statuary bronze:

	Copper	Zinc	Tin	Color
I...	84.42	11.28	4.30	Reddish yellow
II...	84.00	11.00	5.00	Orange red
III...	83.05	13.03	3.92	Orange red
IV...	83.00	12.00	5.00	Orange red
V...	81.05	15.32	3.63	Orange yellow
VI...	81.00	15.00	4.00	Orange yellow
VII...	78.09	18.47	3.44	Orange yellow
VIII...	73.58	23.27	3.15	Orange yellow
IX...	73.00	23.00	4.00	Pale orange
X...	70.36	26.88	2.76	Pale yellow
XI...	70.00	27.00	3.00	Pale yellow
XII...	65.95	31.56	2.49	Pale yellow